

**IN THE UNITED STATES PATENT AND TRADEMARK OFFICE
BEFORE THE BOARD OF PATENT APPEALS AND INTERFERENCES**

In re Application of: **Pavel, et al.**

Docket No.: **APPM/7608**

Filed: **February 11, 2004**

§ Serial No.: **10/776,672**

§ Group Art Unit: **1765**

§ Confirmation No.: **3482**

§ Examiner: **Tran, Binh X.**

**For: METHOD AND APPARATUS FOR
PERFORMING HYDROGEN OPTICAL
EMISSION ENDPOINT DETECTION FOR
PHOTORESIST STRIP AND RESIDUAL
REMOVAL**

MAIL STOP APPEAL BRIEF - PATENTS

Commissioner for Patents

P.O. Box 1450

Alexandria, VA 22313-1450

Dear Sir:

REPLY BRIEF

In response to the Examiner's Answer dated on January 22, 2008, the Appellants hereby submit this Reply Brief to the Board of Patent Appeals and Interferences. The Appellants believe that a one month extension of time fee is due in connection with this submission. The Commissioner is hereby authorized to charge counsel's Deposit Account No. 50-3562 for this fee and for any fees, including additional extension of time fees, required to make this response timely and acceptable to the Office.

REAL PARTY IN INTEREST

The real party in interest is Applied Materials, Inc., located in Santa Clara, California.

RELATED APPEALS AND INTERFERENCES

The Appellants know of no related appeal and/or interferences that may directly affect or be directly affected by or have a bearing on the Board's decision in the pending appeal.

STATUS OF CLAIMS

Claims 1-2, 6-7, 9, 14, 16-17, 21-22, 28, and 30-45 are pending in the application. Claims 1-2, 6-7, 9, 14, 16-17, 21-22, 28, and 30-45 stand rejected as discussed below. Claims 3-5, 8, 10-13, 15, 18-20, 23-27 and 29 have been cancelled. The rejections of claims 1-2, 6-7, 9, 14, 16-17, 21-22, 28, and 30-45 as set forth in the Final Office Action dated February 21, 2007 are appealed. The pending appealed claims are shown in the attached Appendix.

STATUS OF AMENDMENTS

No amendments to the claims were submitted in this application subsequent to final rejection.

SUMMARY OF CLAIMED SUBJECT MATTER

Embodiments of the present invention provide methods for processing semiconductor substrates using optical monitoring techniques. In the embodiment of independent claim 1, a method of removing a photoresist layer includes positioning a substrate comprising a photoresist layer into a processing chamber (*see, e.g.*, Fig. 3, step 304); removing the photoresist layer using a plasma (*see, e.g.*, Fig. 3, step 306); monitoring the plasma for both a byproduct optical emission and a reagent optical emission during the process (*see, e.g.*, Fig. 3, step 308); and stopping the etching upon the byproduct optical emission obtaining a first level and the reagent optical emission

obtaining a second level (*see, e.g.*, Fig. 3, step 310). (Specification, ¶¶[0022]-[0027]; Fig. 3.)

In the embodiment of independent claim 16, a method of etching a photoresist layer includes providing a substrate comprising a photoresist layer to a process chamber (*see, e.g.*, Fig. 3, step 304); etching the photoresist layer using a plasma (*see, e.g.*, Fig. 3, step 306); and monitoring the plasma for both a byproduct optical emission and a reagent optical emission while etching (*see, e.g.*, Fig. 3, step 308). (Specification, ¶¶[0022]-[0027]; Fig. 3.)

In the embodiment of independent claim 35, a method of etching a photoresist layer includes providing a substrate comprising a photoresist layer to a process chamber (*see, e.g.*, Fig. 3, step 304); etching the photoresist layer using a plasma (*see, e.g.*, Fig. 3, step 306); determining an early endpoint indicator by monitoring the plasma for a reagent optical emission while etching (*see, e.g.*, Fig. 3, steps 308, 310); and determining a final endpoint indicator by monitoring the plasma for a byproduct optical emission while etching (*see, e.g.*, Fig. 3, steps 308, 310). (Specification, ¶¶[0022]-[0027], [0039]; Fig. 3.)

GROUND OF REJECTION TO BE REVIEWED ON APPEAL

1. Claims 1, 7, 9, 16, 21-22 and 31-45 stand rejected under 35 USC §103 as being unpatentable over United States Patent Application Publication No. 2001/0027023, published October 4, 2001 to *Ishihara* (hereinafter *Ishihara*) in view of United States Patent Application Publication No. 2002/0135761, published September 26, 2002 by *Powell et al.* (hereinafter *Powell*).

2. Claims 2, 6, 14, and 17 stand rejected under 35 USC §103(a) as being unpatentable over *Ishihara* and *Powell* and further in view of United States Patent Application Publication 2002/0151156, published October 17, 2002 by *Hallock, et al.* (hereinafter *Hallock*).

3. Claims 28, 30 stand rejected under 35 USC §103(a) as being unpatentable over *Ishihara* and *Powell* and further in view of United States Patent No. 6,419,801, issued July 16, 2002 to *Smith, Jr. et al.* (hereinafter *Smith*).

ARGUMENT**Response to Examiner's Answer**

The following discussion is in response to the assertions made in the Response to Argument section of the Examiner's Answer (Examiner's Answer, pp. 7-12).

1. §103 Claims 1, 7, 9, 16, 21-22 and 31-45**A. Claims 1, 7, 9, 16, 21-22 and 31-45**

Claims 1, 7, 9, 16, 21-22 and 31-45 stand rejected under 35 USC §103 as being unpatentable over *Ishihara* in view of *Powell*.

The Appellants argue, and the Examiner admits, that *Ishihara* fails to teach removing (claim 1) or etching (claim 16, 35) a photoresist layer for both a byproduct optical emission and a reagent optical emission as recited in the independent claims.

The Examiner cites *Powell* to teach monitoring a plurality of optical emission including both hydrogen and oxygen emission to determine an endpoint. The Appellants argue that *Powell* fails to teach or suggest monitoring a plasma in a process chamber used from removing or etching a photoresist layer are recited in the independent claims 1, 16, and 35. The Examiner contends that the Appellants argument is not commensurate with the scope of the claims because there is no limitation which excludes the use of an external chamber for monitoring the plasma.

However, independent claims 1, 16 and 35 each explicitly recite monitoring "the plasma" with reference to the plasma used to remove or etch the photoresist. Thus, the plasma being monitored is the plasma used to remove or etch the photoresist. Moreover, the plasma being used to remove or etch the photoresist only exists in the process chamber during the plasma process. To the contrary, *Powell* fails to teach monitoring "the plasma" including the antecedent basis the claims recite, but instead clearly teaches monitoring gas effluents in a secondary excitation chamber (e.g., monitoring a different plasma, not "the plasma" recited in the claims). For example, *Powell* teaches that upon the gas passing out of the reaction chamber, the gas diffuses into an excitation chamber and is excited therein to emit radiation. (*Powell*, ¶[0006].) Therefore, *Powell* clearly teaches the creation and monitoring of an excited gas effluent, and not the monitoring of a plasma being used to remove or etch the photoresist layer

as recited in the independent claims. As such, *Powell* fails to teach or suggest the limitations asserted by the Examiner and a *prima facie* case of obviousness has not been established because the combination of the cited art fails to yield the limitations recited in the claims. Thus, independent claims 1, 16 and 35 are patentable over the combination of *Ishihara* and *Powell*.

In addition to being patentable over the cited art for the reasons discussed above, independent claim 35, is further patentable for the following reasons. The Examiner interprets 'a peak appearing early in the cleaning process as an early endpoint indicator and a peak that occurs later in the process as a final endpoint indicator' in Figure 11 of *Powell* as reading upon the limitations of claim 35. (*Examiner's Answer*, p. 5; see also *Powell*, ¶[0051], Figure 11.) However, at the cited portion relied upon by the Examiner, *Powell* teaches to supply a plasma comprising fluorine, hydrogen and oxygen for use in cleaning or conditioning the chamber walls. (*Powell*, ¶[0051].) As such, the reagents in the plasma process are fluorine, hydrogen, and oxygen. Thus, other gases appearing in Figure 11 of *Powell* (i.e., CO and Nitrogen) are considered byproducts. Therefore, even if a peak appearing later in the process could be used as a final endpoint indicator, the only peak appearing later in the process in Figure 11 of *Powell* is oxygen, which has been established to be a reagent, not a byproduct as recited in claim 35. Hence, independent claim 35 is further patentable over the combination of the cited art as the combination of *Ishihara* and *Powell* fails to further establish determining the final endpoint indicator by monitoring the plasma for a byproduct optical emission while etching as recited in claim 35.

The Examiner further asserts that there is no limitation in the claim indicative to the relative time of the "early endpoint indicator" or which excludes an early endpoint indicator occurring at a point less than half way through the process. The Appellants submit that this contention defies common sense. The Examiner is permitted to construe the claims relatively broadly during prosecution. However, such interpretation must be reasonable and consistent with the specification. The teachings of *Powell* may teach to monitor an emission spectrum for a change that is indicative of something occurring, but that something is clearly not an indicator of the end of the process (early or otherwise) if such an indicator occurs while there is greater than half of the process

time remaining. Such an indicator eviscerates the meaning of the claim limitation that the indicator is an indicator of the end of the process. As such, *Powell* fails to teach or suggest the limitations asserted by the Examiner and a *prima facie* case of obviousness has not been established because the combination of the cited art fails to yield the limitations recited in the claims. Thus, independent 35 is further patentable over the combination of *Ishihara* and *Powell*.

Thus, independent claims 1, 16, and 35, and claims 7, 9, 21-22, 31-34 and 36-45, dependent thereon, are patentable over *Ishihara* in view of *Powell*. Accordingly, the Appellants respectfully request that the rejection be withdrawn and the claims allowed.

B. Claims 31, 33 and 39

In addition to being patentable by virtue of dependence from independent claims 1, 16, and 35, as discussed above, claims 31, 33, and 39 are further patentable over the cited art for the following reasons. The Examiner admits that *Powell* does not use the term “plasma source.” The Examiner interprets the condition of the plasma source recited in claims 31, 33, and 39 as comprising any condition that is related to the plasma source including emission spectrum, wavelength, and gas flow rate of the plasma. The Examiner further states that the Appellants do not claim “what specific condition or parameter of the plasma source that the Appellant would like to determine.” (Examiner’s Answer, pp. 9-10.)

The Appellants submit that this last statement of the Examiner indicates that he is misinterpreting the claim limitation. Specifically, “condition” as used herein, and as consistent with the usage in the specification (without reading limitations from the specification into the claims, but only to shed light on the meaning of the term as utilized in the application), means a state of health of the plasma source. For example, the specifications recites:

The relative intensities of these peaks so measured and monitored could be indicative of the conditions of the plasma sources and chamber surfaces and be used to provide a proper “fingerprint” of a clean or “golden” chamber. The magnitude of the emissions can be used to determine when a cleaning cycle is necessary or whether components

within the chamber are degrading, i.e., certain emissions are indicative of chamber health. (Present Application, ¶[0039].)

Accordingly, the Examiner's assertion that *Powell* clearly discloses the change of the wavelength of the plasma, the emission of the plasma (Figure 9), and the gas flow rate of the plasma (Figure 10) do not relate to the condition of the plasma source as recited in the claims. (Examiner's Answer, p. 9.) Moreover, Figure 9 of *Powell* discloses monitoring changes in the emission intensity of reaction byproducts produced during an etch process. (*Powell*, ¶[0038]) *Powell* fails to teach or suggest how monitoring changes in the emission intensity of reaction byproducts has anything to do with the condition of the plasma source. Further, regarding Figure 10 and the accompanying description thereof, it is clearly stated that the data in Figure 10 of *Powell* are from tests run using gas flow but no plasma discharge in the reaction chamber. (*Powell*, ¶[0039]). Hence, there is no support for the Examiner's assertion that Figure 10 of *Powell* describes the gas flow rate of a plasma. As such, even following the teachings of *Powell*, there is no support for the Examiner's assertion that a plasma source is being monitored and that a condition thereof is being determined.

Thus, dependent claims 31, 33, and 39 are further patentable over *Ishihara* in view of *Powell*. Accordingly, the Appellants respectfully request that the rejection be withdrawn and the claims allowed.

C. Claims 41, 44 and 45

The Examiner responds to the argument submitted in the Appeal Brief by stating: *Powell* teaches to monitoring the plasma emission spectrum in real time during the chamber cleaning process from the beginning to the end in order to monitor the condition of the chamber and to determine when the chamber is clean enough (paragraph 0051-0053). Of course, before the endpoint was reached, the cleaning cycle is necessary and the cleaning process is continued until the chamber is determined as "clean enough" (paragraph 0052). Further, *Powell* also discloses the step of monitoring depletion of material in real time from chamber during cleaning enable timing, control and validation of the cleaning process to determine a

characterization of the chamber condition (See paragraph 0051, Fig 11).

(Examiner's Answer, pp. 10-11, emphasis added.)

As noted by the underlined portions of the Examiner's response, the portion of *Powell* relied upon relates to monitoring a cleaning process (during the cleaning process) and fails to teach or suggest removing (or etching) a photoresist layer using a plasma... and determining from at least one of the monitored optical emissions whether a cleaning cycle is necessary, whether components within the chamber are degrading, or both, as recited in the claims.

Moreover, the Examiner's argument that the cleaning cycle, once started, is necessary until it ends, still fails to meet the limitations recited in the claims – i.e., monitoring a cleaning process (during the cleaning process) and fails to teach or suggest removing (or etching) a photoresist layer using a plasma... and determining from at least one of the monitored optical emissions whether a cleaning cycle is necessary, whether components within the chamber are degrading, or both.

Therefore, a *prima facie* case of obviousness has further not been established with respect to claims 41, 44, and 45 as the combination of the cited references fails to yield the limitations recited in the claims.

Thus, claims 41, 44, and 45 are further patentable over *Ishihara* in view of *Powell*. Accordingly, the Appellants respectfully request that the rejection be withdrawn and the claims allowed.

Thus, in summary, the Appellants maintain that independent claims 1, 16, and 35, and claims 7, 9, 21-22, 31-34 and 36-45, dependent therefrom, are patentable over *Ishihara* in view of *Powell*. Accordingly, the Appellants respectfully request that the rejection be withdrawn and the claims allowed.

2. §103 Claims 2, 6, 14, and 17

Claims 2, 6, 14, and 17 stand rejected under 35 USC §103 as being unpatentable over *Ishihara* in view of *Powell* and further in view of *Hallock*.

The Appellants maintain that the combination of *Ishihara* and *Powell* fail to teach or suggest monitoring a plasma used for removing or etching a photoresist layer for both a byproduct optical emission and a reagent optical emission as recited in

independent claims 1 and 16 from which claims 2, 6, 14 and 17 depend, as discussed above.

Thus, claims 2, 6, 14, and 17 are patentable over *Ishihara* in view of *Powell* and further in view of *Hallock*. Accordingly, the Appellants respectfully request that the rejection be withdrawn and the claims allowed.

3. §103 Claims 28, 30

Claims 28 and 30 stand rejected under 35 USC §103 as being unpatentable over *Ishihara* in view of *Powell* and further in view of *Smith*.

The Appellants maintain that the combination of *Ishihara* and *Powell* fail to teach or suggest monitoring a plasma used for removing or etching a photoresist layer for both a byproduct optical emission and a reagent optical emission as recited in independent claims 1 and 16 from which claims 28 and 30 depend, as discussed above.

Thus, claims 28 and 30 are patentable over *Ishihara* in view of *Powell* and further in view of *Smith*. Accordingly, the Appellants respectfully request that the rejection be withdrawn and the claims allowed.

CONCLUSION

For the reasons advanced above, Appellants respectfully urge that the rejections of claims 1-2, 6-7, 9, 14, 16-17, 21-22, 28, and 30-45 as being unpatentable under 35 U.S.C. §103 are improper. Reversal of the rejections in this appeal is respectfully requested.

Respectfully submitted,

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CLAIMS APPENDIX

1. (Previously Presented) A method of removing a photoresist layer comprising:
positioning a substrate comprising a photoresist layer into a processing chamber;
removing the photoresist layer using a plasma;
monitoring the plasma for both a byproduct optical emission and a reagent optical emission during the process; and
stopping the etching upon the byproduct optical emission obtaining a first level and the reagent optical emission obtaining a second level.
2. (Original) The method of claim 1 wherein the photoresist layer comprises a hardened crust layer.
- 3-5. (Cancelled)
6. (Previously Presented) The method of claim 2, wherein the monitoring step produces signals having first levels while etching the crust and produces signals having second levels after the crust has been removed.
7. (Previously Presented) The method of claim 1, wherein the byproduct is hydrogen and the hydrogen optical emission occurs at a wavelength of about 656 nm.
8. (Cancelled)
9. (Previously Presented) The method of claim 1, wherein the reagent is oxygen and the oxygen optical emission occurs at a wavelength of about 777 nm.
- 10-13. (Cancelled)
14. (Previously Presented) The method of claim 6, wherein the monitoring step produces signals having a third level after the photoresist is removed.

15. (Cancelled)
16. (Previously Presented) A method of etching a photoresist layer comprising:
providing a substrate comprising a photoresist layer to a process chamber;
etching the photoresist layer using a plasma; and
monitoring the plasma for both a byproduct optical emission and a reagent optical emission while etching.
17. (Original) The method of claim 16 wherein the photoresist layer comprises a crust.
- 18-20. (Cancelled)
21. (Previously Presented) The method of claim 16, wherein the byproduct is hydrogen and the hydrogen optical emission occurs at a wavelength of about 656 nm.
22. (Previously Presented) The method of claim 16, wherein the reagent is oxygen and the oxygen optical emission occurs at a wavelength of about 777 nm.
- 23-27. (Cancelled)
28. (Previously Presented) The method of claim 1, further comprising:
comparing the monitored optical emissions to a fingerprint of a clean chamber.
29. (Cancelled)
30. (Previously Presented) The method of claim 16, further comprising:
comparing the monitored optical emissions to a fingerprint of a clean chamber.
31. (Previously Presented) The method of claim 16, further comprising:
determining the condition of a plasma source.

32. (Previously Presented) The method of claim 16 further comprising:
determining the condition of an inner surface of the processing chamber.
33. (Previously Presented) The method of claim 1, further comprising:
determining the condition of a plasma source.
34. (Previously Presented) The method of claim 1, further comprising:
determining the condition of an inner surface of the processing chamber.
35. (Previously Presented) A method of etching a photoresist layer comprising:
providing a substrate comprising a photoresist layer to a process chamber;
etching the photoresist layer using a plasma;
determining an early endpoint indicator by monitoring the plasma for a reagent
optical emission while etching; and
determining a final endpoint indicator by monitoring the plasma for a byproduct
optical emission while etching.
36. (Previously Presented) The method of claim 35, wherein the determining a final
endpoint indicator step further comprises:
monitoring the plasma for a hydrogen optical emission while etching.
37. (Previously Presented) The method of claim 36, wherein the determining an
early endpoint indicator step further comprises:
monitoring the plasma for an oxygen optical emission while etching.
38. (Previously Presented) The method of claim 35, wherein the determining an
early endpoint indicator step further comprises:
monitoring the plasma for an oxygen optical emission while etching.
39. (Previously Presented) The method of claim 35 further comprising:
determining the condition of a plasma source.

40. (Previously Presented) The method of claim 35, further comprising:
determining the condition of an inner surface of the processing chamber.
41. (Previously Presented) The method of claim 1, further comprising:
determining from at least one of the monitored optical emissions whether a cleaning cycle is necessary, whether components within the chamber are degrading, or both.
42. (Previously Presented) The method of claim 1, wherein the monitoring step further comprises:
determining an early endpoint indicator from the reagent optical emission.
43. (Previously Presented) The method of claim 1, wherein the monitoring step further comprises:
determining a final endpoint indicator from the byproduct optical emission.
44. (Previously Presented) The method of claim 16, further comprising:
determining from at least one of the monitored optical emissions whether a cleaning cycle is necessary, whether components within the chamber are degrading, or both.
45. (Previously Presented) The method of claim 35, further comprising:
determining from at least one of the monitored optical emissions whether a cleaning cycle is necessary, whether components within the chamber are degrading, or both.

EVIDENCE APPENDIX

[NONE]

RELATED PROCEEDINGS APPENDIX

[NONE]